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Selection decisions among reindeer herders in Finland

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Abstract: Selection of breeding animals is a tool to improve the revenues in animal production. Information about selection practices and criteria are essential in assessing the possibilities for systematic selection schemes. Attitudes of reindeer herders towards use of selection in improving production were investigated by means of interviews. We interviewed the managers of reindeer herding cooperatives concerning their selection decisions. Fortyfive out of 56 managers answered to the semi-structured questionnaire. Among herding operations, selection of breeding animals was regarded by managers as critical for calf's autumn weight and survival. The main selection criteria were calf's health, vigour, body size and muscularity, dam or dam line, and maternal care. Hair quality and hair length were important as well, while such often quoted traits as antler characteristics, e.g. early shedding of antler velvet and thick antler bases, were unimportant. The results show that reindeer herders i) acknowledge the importance and effects of selective breeding, and ii) have empirical knowledge to list the most important selection criteria.

Key words: breeding objectives; Finland; *Rangifer tarandus*; reindeer; reindeer herders; selection decisions; selective breeding.

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Introduction

Reindeer husbandry has changed over the recent decades and some of the traditional practices have been replaced or supported by new tools and information to increase the herders' revenues. Selection of breeding animals aims at improving the efficiency of meat production per adult female. The body mass and survival of calves are important traits for meat production (Varo 1972; Lenvik 1988; Weladji *et al.*, 2002a; Rönnegård & Danell, 2003; Rönnegård *et al.*, 2003; Holand, 2007). When weight is favoured, selection results in heavier slaughter carcasses and better survival of the calves (Lenvik 1988; Rönnegård & Danell, 2003; Muuttoranta *et al.,* 2010). Also bigger dams produce heavier calves (Lenvik *et al.*, 1988; Weladji *et al.*, 2003).

Traditional knowledge regards the impact of selection on autumn weight very high (Weladji *et al.*, 2002a). Traditional selection practices in reindeer husbandry have, however, not been documented. There is no organized coordination for selection within (or between) herding

cooperatives. Hence selection decisions are to large extent owner-specific. Furhermore, selection is based mainly on calves' performance (Weladji *et al.,* 2002a) and often also on the observations on dam's capacity to raise offspring (Lenvik, 1988; Rönnegård *et al.,* 2003), since maternal effects (Willham, 1967; Rönnegård & Woolliams, 2003) are known to affect calves' growth and survival (Rönnegård *et al.*, 2003; Muuttoranta *et al.*, 2010).

General animal breeding scheme requires: i) individual marking of animals, ii) production records, iii) pedigree information, and iv) controlled mating. There are many challenges in reindeer selection to meet these requirements. The highly unpredictable and harsh environment together with variable management practices causes ample variation in animal weights (Rönnegård *et al.*, 2003). Especially survival over the winter is a very important trait in reindeer husbandry. In recent years, lots of attention has been given to increased predation, which causes losses in the reindeer production in the whole Fennoscandia and may severely reduce the effectiveness of selection (e.g. Danell, 2011).

The possibilities to perform selection on production traits in practice have not been thoroughly studied in reindeer. Varo (1969; 1972) concluded that body mass could be estimated simply as heart girth × back length, and further suggested to slaughter most of the male calves in the autumn and thereby introduce stronger selection in the male side. His recommendations gained popularity and the best males were given prizes within cooperatives and in the whole reindeer herding area. This indicates that the reindeer herders are willing to adopt and apply new information and strategies in the herding operations.

Lenvik (1988) in Norway and Rönnegård & Danell (2001; 2003) in Sweden have studied breeding objectives and selection: They demonstrated the effectiveness of selection and pointed out the importance of both calf weight and dam productivity as selection criteria.

The aim of this study was to find out how the Finnish reindeer herders value selection and what the selection objectives are in practice. We therefore interviewed the managers of reindeer herding cooperatives in Finland to i) assess the importance of selection in current reindeer herding operations, ii) list the most important selection criteria used at present, and iii) describe an overall definition of a good reindeer for breeding purposes or selection goals.

Material and methods

The interviews were carried out among the managers of reindeer herding cooperatives. The managers, in Finnish called "poroisäntä", are 56 in total. The methodology applied in the survey was a semi-structured questionnaire. The question battery included both closed and open questions. There were altogether 42 questions, of which 30 were structured and 12 were open. The questionnaire[1] was mailed to the interviewees beforehand. The actual interviews were done by phone, in order to get more information compared to written answers and allow immediate clarification, while the cost of the work was kept low (e.g. no travelling). One person did all the interviews during the spring 2010, with additional two interviews in the winter 2011.

In the questionnaire there were questions concerning the background (e.g. age, size of own reindeer operations) of interviewee, environmental factors and statistics of the cooperative, and the factors affecting selection decisions (Table 1). Let us consider an example of the question in the survey: "Importance of different factors for selection". At first, the interviewee was asked to imagine to be standing in the middle of a round-up, i.e. the situation where he is making the selection decisions. Af-

1 The corresponding author makes an English version of the questionnaire available on request.

Table 1: The themes and topics of the questions in the survey carried out among the managers of reindeer herding cooperatives. The number of questions is in brackets.

Theme (in italics), and the aspects of the questions
A *Background information of interviewee*
Interviewee's age class, work experience and economic importance of reindeer in the family (6)
B *Environment and management*
Identification and bookkeeping of animals, development of production (6)
Pasture condition, round-up and marking practices, and parasite medication (6)
Additional feeding (6)
Slaughter information (4)
C *Selection criteria*
Importance of different factors for animal weights and selection (2)
Selection criteria, possible variation within the cooperative and prospects for changes (4)
Early calving, avoidance of inbreeding (6)
Carcass quality and its economic importance, ways to improve meat production (2)
D *Additional comments*

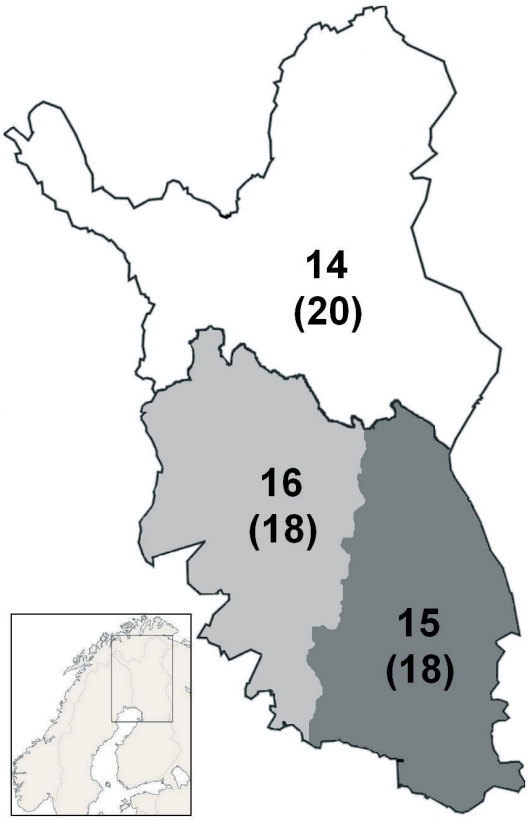

Fig.1. The number of interviewed cooperatives (vs. all cooperatives in brackets) in the three subregions (north, middle and south) of the reindeer herding area in Finland. The map configuration was given by the Reindeer Herders' Association (Paliskuntain Yhdistys).

ter such an introduction, he was asked to grade single factors in selection decision, one by one, using a scale from 0 to 3; from unimportant to very important, respectively. In the questionnaire there were altogether 15 single factors to be graded, and a category "any other factor?" at the end.

During the interview, discussion was based on the questionnaire. Comments were welcomed and discussion included clarifying questions whenever needed. A typical interview lasted approximately an hour. If the manager was well prepared and had the questionnaire form in front of him, the interview lasted a mere half an hour. The longest interviews took as long as three hours. Interviews were not recorded in order to maintain a more relaxed atmosphere, but detailed notes were made on the discussion. The answers were saved in Webropol (Webropol, 2010) and analysed with R (R Development Core Team, 2010).

Results

Of the 56 cooperative managers, 45 were willing to take part in interview, thus the response rate was 80.4%. The respective cooperatives covered all the reindeer herding area (Fig. 1).

Table 2. Background information about the interviewees: work experience and economic importance of reindeer husbandry. *n* is the number of managers in each class.

	n	%
Work experience		
< 10 yrs	0	0
> 10 yrs	45	100
Annual working days		
< 100 days	2	4
> 100 days	43	96
Income from reindeer production		
< 50%	11	24
> 50 %	34	76
Number of reindeer		
< 80 animals	2	4
> 80 animals	43	96

Background of the interviewees

All the interviewees were men and had more than ten years' experience in reindeer herding. All but two interviewees had more than 80 reindeer. Only two interviewees spent less than hundred days within a year in reindeer herding operations, and out of the 45 managers, 34 received more than 50% of their income from reindeer husbandry (Table 2).

Selection criteria

The managers of cooperatives found selective breeding (average score 2.62) and dam's properties (2.60) as the most important factors affecting variation in calf survival and growth. The managers implied that selection criteria were rather similar within a cooperative. The most important selection criteria regardless of calf's sex were calf's health, vigour, body size and muscularity, dam or dam line, and maternal care. Hair quality and hair length were important as well (Table 3).

Table 3. Importance of different factors in selection criteria, graded by the managers. Importance is measured as the average of the scores given in a scale from 0 (unimportant) to 3 (very important). SD is standard deviation of scores and *n* is the number of answers.

Factor	Importance	SD	*n*
Thick antler bases	0.51	0.72	45
Suitability for sledge pulling / racing	0.71	0.88	45
Temperament	0.76	0.84	45
Hair colour	0.93	0.8	45
Sire of the calf	1.07	1.03	45
Sharp antler tips	1.49	1.17	45
Branching antlers	1.53	1.07	45
Early shedding of antler velvet	1.84	1.11	45
Hair quality	2.20	0.83	45
Maternal care	2.42	0.65	45
Dam or dam line	2.56	0.68	45
Calf size	2.56	0.54	45
Muscularity	2.82	0.43	45
Vigour	2.87	0.34	45
Health	2.93	0.25	45

Among the selected traits were of moderate importance antler traits such as early shedding of antler velvet, branched antlers, and hard and sharp antler tips. Calf traits such as hair colour, temperament, suitability for sledge pulling or racing, and thick antler bases had only small effect on selection (Table 3).

Spearman correlations for trait pairs in selection criteria were in many cases not significant (Table 4). Antler traits' scores correlated strongly with each other, while health, vigour and hair quality correlated moderately. Importance of dam's maternal care correlated negatively with calf size, but positively with the calf's vigour score.

Table 4. Spearman correlations among the scores of selected traits assessed by the interviewed managers of cooperatives.

	Health	Vigour	Calf size	Maternal care	Hair quality	Antler velvet shed	Branching antlers	Sharp antler tips	Hair colour
Health	1	0.42***	0.12	0.14	0.39**	-0.02	0.07	0.19	-0.15
Vigour		1	0.11	0.33*	0.37*	0.09	0.02	0.23	-0.05
Calf size			1	-0.38**	0.09	0.08	-0.04	0.01	0.08
Maternal care				1	0.15	0.13	0.17	0.11	0.21
Hair quality					1	0.15	-0.09	0.05	-0.11
Antler velvet shed						1	0.48***	0.78***	0.11
Branching antlers							1	0.45**	0.30*
Sharp antler tips								1	0.04
Hair colour									1

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; P is the probability for a type I error.

In one open question, the managers were asked to describe the properties of a good calf regardless of calf's sex. The most often mentioned characteristics were weight, health, muscularity, round body shape and broad back. A good looking calf was described most often as "*long and large individual, antlers with branches and velvet shed before the round-up*". Almost all the managers answered the question about the importance of body size with words like: "*Heavy calf is good, but the ultimate heaviest calves are not necessarily the very best*".

Dam's influence or maternal effects were in general highly valued. One cooperative manager crystallized his selection criteria in a nutshell: *"The female calf of a good dam could be selected for breeding purposes even early in the summer. The calf's own appearance is almost of no importance, the dam would do everything*". Furthermore, the good dam was described as follows: "*Large female, makes good calves and stays in good condition over the winter.*" "*Takes care of its calf, has good antlers, protects the calf.*" "*Has not too big bones, but broad back with a furrow holding rain water.*" "*Has good hair, stays in one area, and is eager to dig.*"

Other factors related to selection

From the open questions it came obvious that the managers of cooperatives were aware of inbreeding risks and benefits from a regular turnover of breeding males in the herd. Exchange of breeding animals within and between cooperatives found to be a common method to avoid inbreeding. Of the interviewed managers, only seven said that the cooperative did not have any policy of actively purchasing males from other cooperatives.

Animal identification is a fundamental requirement for efficient selection. Among the managers, 56% marked all their breeding animals individually, whereas 24% did not use any individual identification. Of all managers, 33% had bookkeeping system for individual animals.

Whether the animals were tagged or not, 71 % of the managers said that they would know individually majority or all of their reindeer, and 20% recognized all of their animals. Selection is usually favouring progeny from good dams and therefore remembering the dams is important. Of the managers, 58% said that they would be able to identify dam for at least half of their reindeer.

Discussion

The interview study showed that selection criteria are clear and concentrate on the traits tied to meat production, maternal effects and survival. The managers regard selective breeding among the most important factors affecting calf's performance and survival over the first half year, and understand clearly the importance of the quality of their breeding animals.

Interview approach

Instead of interviewing a random sample of reindeer herders, we focussed on the managers of reindeer herding cooperatives. The manager is elected by the members of cooperative and is responsible for the practical activities in his/her cooperative (Poronhoitolaki, 1990), including the selection of animals for breeding in debatable cases. The managers of cooperatives are very experienced about the reindeer herding and decision making. Including the great majority of the cooperative managers in this census study gives a comprehensive picture of practices in the whole Finnish reindeer herding area. The high percentage of answers indicates very high interest in the issues related to better management and use of selection in reindeer husbandry.

The same interviewer did all the surveys over a short period to minimise possible variation due to the interview situation. The experiences gained in farmer interviews of another project (Gandini *et al.*, 2010) were used in the preparation of the questionnaire and in the interpretation of the results.

The current methodology would not allow formal testing of hypotheses or contrasts between the factors in the selection criteria. Participatory definition of selection weights via open comparison may be a more quantitative approach than giving scores to individual traits at a time (e.g. Gizaw *et al.*, 2009). A satisfactory analysis would require a very high number (possibly hundreds) of participants.

Selection practices

The most important result in our study is the finding that reindeer herders are relying on long experience and accrued traditional knowledge about the relationship between the production traits and survival and vigour. When we assess our findings on selection criteria and practices, the obvious baseline studies are those by Varo (1969; 1972), Lenvik (1988), Rönnegård & Danell (2003) and Rönnegård *et al.* (2003).

Because the number of reindeer is limited by quota, there is very high and systematic culling (i.e. strong selection) every autumn. The optimum herd structure (Lenvik 1988) is determined by the maximum number of prime age females and thereby selection among female calves is less intensive, e.g. the statistics in Finland in the herding year 2009/2010 (Paliskuntain yhdistys, 2011) show that the proportion of breeding males in a cooperative was on average 6 to 8%, with minimum of 2% and maximum of 15%. Because the total culling rate of calves was 29%, it follows that some 50% of female calves were culled which would indicate that the herders are empirically aiming at the optimum herd structure. In most of the cooperatives, selection among calves is based both on their own and their dam's performance. Such a selection can be effective (Rönnegård & Danell, 2001; Rönnegård & Danell, 2003). As far as we know, animals are never weighed at the autumn round-up and selection is based only on eye-balling the animals. This could obviously compromise the selection efficiency.

The cooperative managers think that selective breeding is very relevant for improving meat production. The heritable variation in the calves' weight and survival and in dam's maternal ability are the key elements in selective breeding (Varo, 1969; 1972; Lenvik, 1988; Rönnegård *et al.*, 2003; Holand, 2007; Muuttoranta *et al.*, 2010). There is also evidence that the theoretical predictions of selection response on body weight

have been realised in practice (Rönnegård & Danell, 2001; Rönnegård & Danell, 2003).

Selection criteria – calf's own performance

The managers base their selection decisions on easily observable exterior traits of animals themselves, because there are no measured records available on animals or their relatives. Regardless of calf's sex, the muscularity and size of calf have a high priority among the selection criteria (Table 3). Due to the harsh living conditions, health and vigour are more important in reindeer than in the farm animal species. It is well known among the managers that the ultimate heaviest male calves have a risk of perishing in the hard winters. Sexual selection is favouring big males (e.g. Mysterud, 2003). Helle *et al.* (1987) stated how normalizing selection for body size is expected to occur in male calves towards the end of the winter, because the ultimate largest calves would suffer from the diminishing feed resources. In the females, the selection focused only on calf growth may lead to compromises in maternal ability (Holand, 2007; Muuttoranta *et al.*, 2010). Additional feeding can be used to compensate the feed shortage. Large calf body size would follow from a fast growth during the summer (Varo, 1972; Lenvik 1988; Weladji *et al.*, 2002b; Weladji *et al.*, 2003).

The managers stated that good indicators for health and vigour are traits such as hair length, hair quality, and sharp and hard antler tips, while poor health and survival are associated with long hair, soft and round-shaped antler tips, and late shedding of antler velvet (cf. Table 4). In support of the managers' views, Varo (1972) wrote that good hair quality correlates with good overall condition.

In selection less attention is given to hair colour, animal's suitability for sledge pulling and the thickness of antler bases (Table 3). According to the managers' knowledge all-white calves have poor survival. They said that such animals are in deep sleep, while animals, in general, are rather alert. This kind of belief about the link between white colour and resting behaviour is supported by similar observations (e.g. poor hearing) in other species (e.g. Bergsma & Brown, 1971). White calves are often culled, while colours receive very little attention. Some managers, however, like exceptional colours, and a rare type may be favoured as a decorative speciality in the herd. From a management point of view, such an animal may help in spotting a whole herd in the open pasture areas.

Selection criteria - maternal traits

The managers do appreciate maternal capacity of reindeer females and consider selection of dams important (Table 4). Maternal abilities are inherited and are considered important in reindeer husbandry (Rönnegård *et al.*, 2003; Muuttoranta *et al.*, 2010). Dam's condition – depending on weather and environmental conditions and possible extra feeding – may influence calving rates (Lenvik, 1988; Rönnegård *et al.*, 2002). Calves from good dams would usually survive well over summer (Weladji *et al.*, 2006). The dam of a calf could be easily identified, whereas sires are known only in very rare cases. Therefore it is feasible to consider dam information in selecting the calves for breeding.

However, the precise quantification of the maternal ability for a particular dam is hard to estimate due to missing information on pedigree and appropriate trait measurements (calf weight, survival, dam's milk production, etc.). A good dam would every year bring along a good calf and protect it against herd companions and even predators. The dam's milk production has an effect on early growth of the calf (cf. Shaat & Mäki-Tanila, 2009).

Negative correlation between dam's maternal care and calf body mass in autumn has been reported for reindeer (Muuttoranta *et al.*, 2010).

It is in line with the results from other mammals (Meyer, 1992; Roy *et al.*, 2007; Shaat & Mäki-Tanila, 2009; Tosh & Kemp, 1994). This seems to be also an empirical observation made by the managers. Among the scores given them in the interviews, there is a negative correlation between maternal care and calf size, and positive correlation between maternal care and calf vigour (Table 4).

Other factors related to selection

Exchange of breeding animals would stem from high awareness about harmful effects if inbreeding and need for 'new blood'. At present individual herders import males into their cooperative, while this could be done in more organized way. Inbreeding needs to be prevented by a restricted use of males, at the moment. Matings are not controlled by herders (Rönnegård & Danell, 2001).

The challenge in reindeer selection is individual identification, e.g. use of collars or ear tags. It is very encouraging how the interview revealed that more than half of the managers mark the reindeer individually. This is indicating an interest to collect information for selection. Of course the marking would also help to find the owner for the reindeer killed by a predator. The existing practices of animal identification and bookkeeping could be a good start for recording of production performance and utilisation of available information for selection decisions.

Despite poor or completely missing markings, large majority of the managers recognise individually most of their animals. Many also claim to remember what the calving success and the quality of the calves of individual females have been over the years. Strong tradition in breeding selection exists. There is also evidence how reindeer herders are willing to improve their practices and to adopt new technologies and methods in their traditional livelihood. The existing practices of using individual markings on animals and pedigree recording could possibly be used on much wider scale. The most challenging issue is the initiation of weight measurements. The separation of the calves' direct genetic and maternal components would require practical way to assign the sires to the calves. The only existing solution to that is resorting to molecular genetic information. Fortunately the cost of such technology is becoming lower and lower, while the needed information is obtained more and more rapidly.

Conclusions

The results show that reindeer herders i) acknowledge the importance and effects of selective breeding, and ii) have traditional knowledge and confidence to list the most important selection criteria. Their selection practise is in accordance with scientific findings, both emphasizing the need to simultaneously select for both calf's growth and on dam's maternal capacity.

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2 Each year no. 2 of the Finnish reindeer magazine, *Poromies*, publish statistics of Finnish reindeer production.

Abstract in Finnish: Porojen jalostusvalinta on työkalu porotalouden taloudellisen tuloksen kehittämiseen. Jalostusvalinnan tehokkuuden tarkastelua varten tutkimme poronhoitajien käyttämiä siitoseläinten valintakriteereitä haastattelemalla Suomen poroisännät, puhelinhaastatteluiden vastausprosentti oli yli 80 (n = 45). Vasojen syksyisen painon vaihteluun vaikuttavista tekijöistä tärkeimmiksi koettiin eläinten jalostusvalinta ja emän ominaisuudet. Keskeiset valintaperusteet taas olivat vasan terveys ja elinvoima, lihaksikkuus, emä ja emälinja, vasan koko sekä emän hoitokyky. Karvan laatu ja pituus olivat myös tärkeitä valintapäätöksissä, kun taas kelosarvisuus tai sarven juuren paksuus eivät olleet merkittäviä. Paliskunnissa on käytössä selkeä ja tiukka valinta. Haastatteluissa kävi esille, että poroisännät tiedostavat jalostusvalinnan merkityksen arvostavat hyviä emiä ja pystyvät arvottamaan jalostusvalinnan kriteerit käytännössä.